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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

TOWN HALL ON THE AIR

Guest Speaker

DR. JAMES C. FLETCHER

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P R O C E E D I N G S

VOICE: This is Town Hall on the Air, an impartial forum dedicated to civic education and to the discussion of current public issues.

Each week Town Hall, in cooperation with this radio station, presents as a public service an outstanding speaker. Town Hall and this radio station assume no responsibility and disclaim any liability for the statements or opinions of the speaker.

Today that speaker is the Honorable James C. Fletcher, Administrator, National Aeronautics and Space Administration, better known to us as NASA; addressing us on a look at the new NASA program.

Between 1961 and 1973, 30 American-manned spaceships were launched carrying a total of 42 astronauts, who explored the surface of the moon, orbited the earth in instrument-laden capsules, or studied their home planet and its neighbors from Skylab.

What is next in space?

What is ahead for the National Space Program at the ending of the 20th century?

What are its priorities; the search for extraterrestrial life, more planetary exploration, earth-orbiting manned bases and laboratories, space colonization, or use of space techniques for the world's energy needs?

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Dr. Fletcher was named Administrator to NASA in 1971. In government he has served on many commissions and agencies, notably the President's Scientific Advisory Commission and the President's National Crime Commission.

In business he has been associated with many of our outstanding contractors in the aerospace industry.

May I present Dr. James C. Fletcher.

DR. FLETCHER: First, the Space Shuttle Program.

This is our major effort to develop new space capabilities in this decade, much as the Apollo Program was our major effort in the 1960s.

The space shuttle, of course, is something that has never been built before, and we had to first invent it and make sure that we could build it at a reasonable cost. And I see some gentlemen here that are going to do that for us from Rockwell and other companies, Rockwell being the leading contractor on the orbiter, and make sure that we can build it at a reasonable cost.

(Laughter.)

Now we are building it, and we are going to fly it in 1977, first piggyback off a 747 and bring it into operational use in 1980.

Some of you know very well what the space shuttle is and what we are going to use it for, and why we need it. But others may be wondering.

In general terms, I think the space shuttle is the key to successful use of space in the 1980s, and really is the only future that America has in space; much the same, you might say as the DC-3 was to public transportation, or public air transportation in the 1930s.

In more specific terms the space shuttle is a reusable spaceship that will give us a cheaper way to get payloads into orbit and to bring them back, and, if necessary, to repair payload spacecraft of all kinds on orbit.

As you also know, many of you, the support for the space shuttle has been very strong in Congress and in the White House since it began in 1970. We expect to finish the program on time without any technological problems that are major, and without any political problems, we hope.

We must remember that the space shuttle is not an Apollo spectacular, but is basically a truck. We hate to use that term because it is a very sophisticated device, but its usefulness in the same sense that a truck's usefulness, depends on what it hauls and what its payloads are. And that brings us to the main activity I would like to report on.

In one area, we call it the space applications area, we are demonstrating the practical benefits that can be produced by spacecraft in earth orbit. When we say earth orbit, we mean within 25,000 miles of the earth, and staying there. That is a rough description of what we call near space.

I am not going to talk about applications generally, but I think it might be worthwhile just to recapitulate what some of the applications satellites are.

You already know about weather satellites, and communications satellites. You may also have heard about the earth resources technology satellite, ERTS, as we call it. This satellite produces detailed images of every point on the earth every 18 days,and presents these images in four color channels, two of them in the infrared, through a data link to a computer on the ground.

And when we ask the computer to print out the information that we need, this yields extremely valuable information about the world's food and water supply, about the way that land is being used, and about possible new sources of scarce natural resources.

Our present applications satellites will be made more versatile, larger, and generally much more productive for use in the shuttle era.

We are also finding other new practical uses of earth satellites. Perhaps the most important one coming up is for global environmental monitoring. And this I will have something to say about a little later.

Another example of space applications, is that we have demonstrated that laboratories in earth orbit can take advantage of the complete vacuum and the absence of

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gravity and use them to produce absolutely new products which can't be produced anywhere on earth. And we ran some very interesting, and I am proud to say, successful experiments on the Skylab Program that we completed last March.

One of the experiments was the development of brand new crystals, and we were able to produce what we call -- I have to go into this -- Indian antimonite crystals(?), which were purer than any that have ever been produced on earth. In fact, they were quite unique to look at under a microscope. You could tell they were different. And we began to realize the value of these crystals running into the millions of dollars.

So we decided to present one to President Ford about three weeks ago, along with Howard Johnson, Chairman of the Board of MIT, whose faculty participated in this experiment.

The President called this symbolic bit of space-made crystal, a reminder of the new opportunities available to us through our national investment in science and technology.

We expect space manufacturing to be a big business in the 1980s. People from MIT and also from the General Electric Company have made estimates of the kinds of sales that can be obtained from space manufacturing, and their

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estimate is between $1- and $2-billion per year of various kinds of things manufactured in space.

Again, I don't plan to go into that in detail, unless you have further questions on it.

We are also looking at many other, what we call space applications satellites, and one of the more interesting and popular ones is generation of electricity in space by simply collecting solar energy. Space is the best place to collect solar energy. But then you have the problem of getting it back to earth. And we plan to do that through means of microwaves, and that involves transmission of hundreds of megawatts of power to earth stations after collecting them through solar collectors in synchronous orbit. That is 25,000 miles out; a satellite is stationary, remains overhead.

This can be done, technically. The problem is, can it be done economically?

And I would say there is some real question about that. The principal one being, how costly are solar cells going to be; and a number of people are working on that problem, trying to reduce the cost of these little solar cells which we use all the time in the space business. It is absolutely necessary for powering many of our satellites. And I think JPL, as a matter of fact, is going to be a major participant in that cost reduction program.

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Now, I would like to turn to a third area of NASA space activity, and that is the development of new scientific satellites in earth orbit to study the solar system and the universe.

The large space telescope that we are working on is a good example of the bigger and the better scientific satellites that the space shuttle will be able to launch and service in the 1980s.

The space telescope that we are planning to build is not as large as the largest on earth, it would be about 100 inches, but it will have far better resolving power than the best earth telescope because there is no atmosphere between you and the heavenly body that you are studying.

We anticipate that the resolution will be a factor of ten better than the best earth-based telescope. Resolution is kind of interesting as a scientific term, but to give you some idea in practical terms, if you were able to see Tokyo without the earth's being in the way -- if it were a flat earth -- you could see the headlights of a car in Tokyo, and you could see that there were two headlights instead of only one. That is the kind of resolution we are talking about for the LST, or large space telescope.

One of the main astronomical gains from this telescope will be that we will probably be able to see the edge of our universe.

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Now I understand recently there are new stars being discovered that are older than our universe. If that is the case, where did they come from, and there will probably be such things beyond the edge of our current universe.

So that will be a fascinating study,indeed.

Well, the large space telescope is a fascinating example of what can be done with something like the space shuttle.

Perhaps though, we should get closer to home -- a little closer to home -- and look at the planets, which is the fourth main area of NASA space activity. And I think it may be worthwhile to develop that one a little bit since we had a very spectacular mission last night, and we will talk about that in just a minute.

In the planetary programs for this decade and also the next, we are proceeding in a methodical step-by-step fashion, but in many ways these new voyages of discovery have already been as exciting and as rewarding as our exploration of the moon in the Apollo program. And, of course, these are much less costly.

Within the past year, our small automated spacecraft have carried out very successful missions to three different planets, Venus, Mercury and Jupiter.

And in 1976 we will land two Viking spacecraft on Mars to seek the first concrete evidence of extraterrestrial

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life.

I got into a little trouble in a news conference this morning by mentioning that there conceivably might be plants and animals, and I made a very quick caveat that it was extremely unlikely that we will see those animals and plants, but if we do find any kind of life, it will be the very elementary form like algae or bacteria. But I am very worried about what might appear in the papers tomorrow.

(Laughter.)

We are very proud of the excellent performance of the two tiny spacecraft, Pioneer 10 and Pioneer 11 that we have sent to Jupiter and beyond.

As you know, Pioneer 10 passed within 81,000 miles of the liquid surface of Jupiter about a year ago. Late last night, about 9:30, Pioneer 11 passed much closer to Jupiter, within 27,000 miles, than we had ever passed before.

By the way, it was 9:30 that it went past, but it was about 10:20 by the time we got the signal back, because it takes light about 41 minutes to travel from Jupiter to our own planet.

You might say that this turned out to be a fabulous success in every way. We were worried about the radiation belt and indeed, got higher radiation intensity, particularly in the so-called energetic protons, than we had anticipated by almost an order of magnitude. But this turned out to be a very

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brief peak and we went through it quickly. And all it did was turn on all of the programmers that were not supposed to be turned on. So we got very bad data.

It is like your electronic control of your TV, remote control of your TV. Well, we had 43 of these turned on while we went through the radiation belt, but it did not do any permanent damage. We did not lose any data before we went behind the planet. We did lose a little while we were behind, because the memory was clobbered just a little bit. And they are trying to sort that out now.

But by and large, we -- all the instruments are now working. The data is coming in as per schedule, and we now have a much better idea of what the planet Jupiter is like than we ever had before. But I suspect it will be a year or two before they sort out all the data.

We also, en route, took some excellent pictures of two of the moons of Jupiter, Callisto and Ganymede. These are the two largest moons on Jupiter, and I could say a lot about these two moons, but time doesn't permit. Suffice it to say that these are very interesting moons; more features than we had imagined. They both seem to have an atmosphere, and Callisto particularly, seems to have an ice cap. And what the ice is made of, we don't know. It is very likely carbon dioxide or ammonia.

As you know, Mars has a carbon dioxide ice cap.

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But, it is conceivable even that it could be water. We will have to go back and see at some later time.

Pioneer 10 and 11 are the first spacecraft, as you know, to explore the outer planets; that is, Jupiter, Saturn, Uranus, Neptune, Pluto.

Their speed at the launch had to be more than 32,000 miles per hour. And the spacecraft are extremely small, they weigh less than 600 pounds each. But their performance and reliability has been very close to unbelievable.

For example, Pioneer 11 passed Jupiter exactly on target; they said last night, within 17 seconds of the program time, after a voyage of almost two years and a half a billion miles. So our guidance equipment is doing very well, and again we can thank the Jet Propulsion Lab, and Dr. Pickering for the work they do on tracking these spacecraft.

Pioneer 11 has also set a new speed record for man-made objects by coming so close to Jupiter and drawing on that planet's gravity. And we are planning to do that more and more in the future, using planets to give us a kick on into the rest of the solar system.

It passed that giant planet at a speed of more than 100,000 miles per hour. And that is hard to imagine, 100,000 miles an hour, but to give you a reference point, that is 55 times as fast as a bullet leaves the muzzle of an

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army M-14 rifle -- 55 times as fast as that bullet. So it is going at a pretty good clip.

Sending Pioneer 11 this close to Jupiter has been a remarkable feat of celestial navigation. We launched Pioneer 11 on the same conservative course that we gave Pioneer 10, because at launchtime, Pioneer 10 had not even reached Jupiter.

But when the results began to come in from Pioneer 10, our space navigators at Ames Research Center, and at JPL were able to look at Pioneer 11 and change the course for a much closer look at Jupiter and from a new angle.

And we are also getting a big bonus from the Pioneer 11 course change; we are using this increased speed to hurl it beyond Jupiter on to the next pattern -- next planet, which is Saturn, in 1979. Now, we are taking the long way around because Saturn and Jupiter are not lined up at the moment, and so we are having to go up over the ecliptic and on to Saturn. And it is going to take about five years.

But nevertheless, we think there is a fair chance that the spacecraft will survive for that length of time, and for that reason last night at 10:25, I christened the Pioneer 11, Pioneer Saturn, and the focus will all be on Saturn in the months to come.

Planetary exploration does take a great deal of patience. As you see, we have to wait five years for a

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reading on the next planet. It can't be done in one big push like the Apollo program. We have to move step by step and decade by decade.

But even so, a great deal will be learned, and many exciting voyages will be made during the remainder of this century, and during our lifetimes.

Now, let's look at some of our plans for exploring the planets with larger and even more productive spacecraft in the 1980s, and the late 1970s.

In '77, we are going to launch two Mariner type spacecraft to fly by both Jupiter and Saturn,and these spacecraft will weigh about three times as much as the Pioneers that just passed, and should give us very much more detailed information on both of these planets.

According to tentative plans, we expect to launch as many as ten Mariner or Pioneer spacecraft to the outer planets in the 1980s, and this would include flybys of Uranus and Nepture, probes into the atmospheres of Jupiter, Uranus and Saturn, orbiters around Jupiter and Saturn, visits to at least one comet, and also to the asteroids.

It is also possible -- and this is why I mentioned it earlier, that by 1990 or 1991 we will send two very heavy spacecraft to orbit one of Jupiter's moons at an altitude of about 55 miles. If there is no atmosphere, there is no problem of orbiting in low altitude.

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And possibly even land an instrument package including a TV camera, on this particular Jovian moon.

Well, that takes us all the way to 1991, and I think maybe we ought not to speculate beyond that period of time.

Also, in 1976, however, as I mentioned, on the Fourth of July 1976, we will soft land a Viking spacecraft on the surface of Mars. This will carry TV cameras and a very sophisticated automated laboratory to seek evidence of life on Mars.

A second Viking lander equipped with the same instruments will be sent to a different area of Mars, a few days or possibly weeks after the first one.

Of course, if we do obtain evidence of life on Mars, and that is why I guess it came up in the press conference, it will have indeed a profound impact on our thinking about mankind, and certainly give new impetus to our drive to explore the system -- the solar system -- systematically for evidences of life elsewhere.

Needless to say, the phenomenal success of Pioneers 10 and 11 also helps to win wide support for new efforts to carry on these great voyages of exploration, which are becoming recognized as one of the outstanding achievements of this century, comparable to the voyages of exploration that marked the 14th and the 15th centuries of our era.

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Now, the fifth major activity in NASA is a little harder to define, but nevertheless is very important to the country and to NASA itself.

In addition to exploring space and using spacecraft for practical benefits, we are making an intensive and continuing effort to identify ways in which new space technology and space skills can be put to non-space activities here on earth.

Space age technology is already being used widely in such fields as medicine, home and industrial safety -- in fact, I think we have a member of the firefighters group here today that NASA has been working with -- law enforcement, environmental protection, development of new energy sources, and the solution of many urban problems.

Our standard of living and our world trade position depend in large measure on our continuing leadership in the development and uses of new high technology.

And I won't try to define high technology, but simply mention that since we have a number of people here from Rockwell, an example of what I mean by this technology transfer.

Out at Canoga Park we now have an offshoot of the Apollo engine problem being used to produce -- it is a rocket-produced electricity. And hopefully -- or not hopefully, I guess it is already planned to produce electricity in a steam-generating plant in Chicago, Illinois. I guess the plans have not changed for that, have they, Joe?

So this -- here we are using rockets for generation of electric power, and that is an example close to home that all of you can recognize.

We are encouraging this program to the best of our capabilities, although we are a government agency. It is industry that has to make this transfer. But we have a -- what we call a technology utilization program and in this we helped finance six regional dissemination centers, one of which is here in Southern California. We call it the Western Research Applications Center at the University of Southern California.

And this center, like the other five, has computer access to the entire NASA data bank.

Now I would like to skip along and simply indicate that we have a very challenging program ahead, and it promises very rich returns. And we do not plan to change our level of spending any. We have come down a factor of about three from the peak in 1967, peak of the Apollo program. And we are now spending at the rate of about $3 billion a year.

At this level we can do all the things that I described earlier. And I think we will continue to have strong support, although in some areas we may have some difficulty.

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I think the shuttle is in very safe -- in a safe situation; the aeronautics program is safe; the applications program is safe.

If there is any place that we are vulnerable, it would be in our space science and planetary exploration program, because that has long-range benefits, and in times of stress, economic stress, the focus always tends to be on solving our problems right now in saving money.

And so, I think that we will go ahead with these scientific programs, but in support of this, I would like to make four principal points.

Point number one: It is incorrect to say that the space science programs can be put off indefinitely. We now have the teams in being to do this kind of work. They are an important national resource, and an important resource for all of mankind. They must be given a challenging work to do, or their unique skills and experience will be lost.

Space exploration, to be productive, can't be a now and a then activity. It must be a steady, even level of effort.

Point two: Space science does produce practical benefits. We can't always predict what they will be, but they are inevitable. The more we learn about the atmospheres of other planets, the better we will be able to understand the weather and climate on earth, and the better we will be able

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to understand and protect our own atmosphere from the kinds of pollution that may destroy life on this planet, if we are not careful.

I am a little reluctant to read this next quote, but as you know there has been some concern recently about the effect of pollution, particularly aerosols, in the atmosphere cooling down our entire planet. And it has been estimated that if our planet, on the average, would reduce its temperature by about 4 degrees Centigrade,that would bring on the ice age.

And that is true. If you could keep it, every place on the earth on the average 4 degrees cooler,the chances are the glaciers would return.

Well, we don't know the answer to this, because other people have calculated that preventing the sun's rays from getting in, is probably true, but also these aerosols prevent the infrared radiation from getting out. And some others have calculated that indeed, it might warm instead of cool.

So I will read this quote. I didn't dare make this statement myself, but this comes from a NASA publication.

(Laughter.)

"It has long been established that a sustained drop in the average temperature of the earth's atmosphere of only 4 degrees Centigrade could trigger

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another disastrous ice age. However, it has been very much debated whether the aerosols that we are dumping into the earth's atmosphere would cause a temperature rise or a temperature decrease.

"One argument said that the smog would block heat from the sun from reaching the earth's surface, and therefore would cause a cooling trend.

"The counterargument said that smog would prevent infrared heat from radiating off into space and would therefore increase the temperature."

Now comes the controversial point.

"The answer to this debate came from the Mariner 9 data during the clearing of the great 1971 dust storm on Mars. Temperature profiles all the way down through the atmosphere to the surface were continually recorded as the Mars atmosphere went from a very dust-filled condition to a final clear state. And it was shown during that period that the fine aerosol dust particles caused a drop of over 20 degrees Centigrade in the surface temperature of Mars, confirming that much more smog aerosol pollution in earth's atmosphere could indeed set off another ice age."

As might be expected, this opinion is not yet fully accepted in the scientific community, but I think it

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does illustrate vividly the kind of contributions that our planetary investigations can make to identifying and solving vital problems affecting the future of life on earth.

We wouldn't want to try that experiment on earth, filling the atmosphere with aerosols to see if it would lower the temperature by 20 degrees. But we can do this on Mars.

Point number three: These scientific programs force the development of valuable new technology, or development of atomic power sources for the tiny Pioneer spacecraft that are exploring Jupiter and Saturn is one example out of many.

The automated laboratories that will land on Mars in 1976 will advance the art and science of cybernetics and benefit us all in many ways.

As a nation, we can make an important part of our living from the sale of high technology producrs and processes abroad.

I, personally, don't know of a better way for the federal government to help American industry keep ahead of competition, than investing in high technology. And I think that was the thrust of the President's remarks on receiving this crystal the other day, that that is the way that we can be competitive abroad.

Point number four: This may escape some of us,

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but nevertheless I think is a valid point.

Our space science programs, and our voyages to the planets are a special kind of investment. They are more than an investment in high technology or in potential practical benefits; they are more than an investment in a better America; but I speak more of a long-term investment in the future of the human race.

We have the capability to begin acquiring the technology and the experience we need to move some of our people beyond planet earth and establish the first colonies in either earth orbit or solar orbit, or on the planets.

No other human beings in the history of the world have had this capability. Our forefathers, down through the ages, could only dream of such ventures. We, now, have the capabilities and the clear challenge to start making these dreams come true.

The present state of the world with threatened overcrowding and diminishing natural resources is giving us a push as well.

Pioneer, Mariner and Viking are blazing a trail for us, and our aim is to keep these trailblazers on the job and to follow them in due time with people, extending man's habitat beyond the earth and into the solar system.

Thank you very much.

VOICE: Thank you, Dr. Fletcher.

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Town Hall now moves into the question and answer period, in which questions asked of Dr. Fletcher by the audience, are restated by the moderator, Roland Headly, executive director of Town Hall.

QUESTION: Would you comment on the Soyuz, the Soviet Union and the U.S. joint endeavor, what the state of it is at the present time, and what the future holds for it?

DR. FLETCHER: Well that program, of course, is going very well. We call it the ASTP program, Apollo-Soyuz Test Program. Most of the technical problems have been worked out on both sides; the training program is essentially complete; our astronauts speak Russian and their cosmonauts speak English; we do have some simulation to complete and we will have a flight-readiness simulation next spring.

The Russians have gone the extra mile and put up several practice flights. We had two earlier flights unmanned, I think, last year or earlier this year, and then, of course, just yesterday they put up what we call the precursor, which is the first precise simulation of the ASTP flight next year with men aboard.

As near as we can tell, that went very well, too, and NASA is tracking from nine tracking stations, their vehicle and we are receiving periodic reports from the Russian, Soviet control station in Kolingrad(?) as to how the program is progressing. God willing, no further difficulties,

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that program ought to be an extremely successful program about July 5th of next year.

QUESTION: If the high technology that we have achieved in the various aspects of science, not only the ones that you have talked about today, but the various aspects -- and you indicated this is one of the things that will be a principal product, the question is, is there not a good chance that our State Department, in a well-meaning gesture, might give away our state of the art?

DR. FLETCHER: Not any more. We don't give away things any more. Everything that we do at NASA is always done on a quid pro quo basis. We will give you something if you will give us something of approximately equal value.

In the case of the Soviets, it has to be in kind. We don't take money, but we take results. And with other countries in the world, we take money.

So there is no danger, at least in the foreseeable future, of any kind of a giveaway program. This is particularly true at NASA, at least as long as I am there, because I don't believe the U.S. should invest all this kind of money in high technology and give it to people for nothing. I think we are in a competitive world, we need to let the rest of the world know that,and amazingly enough we have had no difficulty. As long as they understand the basis, they have been willing to contribute in many different ways.

The Europeans, for example, are contributing 400 million to build a part of the space shuttle which we call the space lab. The Japanese are willing to pay for the work that we are doing on some of their applications satellites.

Just recently we even charged for the use of the ERTS satellite. We have a number of overseas stations; one in Canada, one in Brazil, one in -- one just building in Italy, and one starting in Venezuela, another one starting in Iran, and soon probably Italy and other countries, there was no problem at all in simply charging them rent for the use of the satellite as part of the contract. Even though in principle they could use the satellite free by, I suppose, cheating, there was no problem at all of them agreeing to pay us a fee for this service.

And I think that will be the future pattern of the U.S., as far as NASA is concerned anyway, and I think generally as far as the federal government is concerned.

QUESTION: You mentioned the possibility of manufacturing things in orbit simply because of the availability or inevitability of vacuum.

Is there a possibility that such manufacturing would be economically viable in the '80s?

DR. FLETCHER: I think there was a question of whether it would be economically viable, and also whether there would be a permanent space station.

There will be a permanent space station, almost certainly in the '80s. But it will be Soviet. They realize the advantage of this the same as we do.

We have chosen the other route. We have chosen to go into space for shorter periods of time, not a permanent space station with the so-called space lab. This would go into space for periods of anywhere from seven days to month. But that, we think is adequate to do all the space manufacturing that we need to, and I think will be less costly.

Now it may be that later in the '80s, we will build a permanent space station, and many designs have been made of that possibility. But I think it is not likely as long as the space lab turns out to be a more economical way to do it, that we will go to a space station for that purpose.

We are just keeping that option open.

So summarizing, there will be a space station in the 1980s, it will be Soviet, it is possible that we will have one later in the 1980s, but the space manufacturing will undoubtedly be done by the space shuttle in the space lab itself.

QUESTION: I would like to push that question just a bit.

You mentioned something like an Indian antimonite. I will let you say the word, whatever it was. I assume that is a new substance that cannot be formed outside of a vacuum.

Are there other things like this?

Would you go into a little bit of detail about what can be done economically there that cannot be done here, so that we have a better feel for it.

DR. FLETCHER: Well, in the first place, I want to correct an impression. You can grow Indian antimonite on the earth, but you can't grow pure crystals the way they were grown in space. And you only need to look at them under a magnifying glass to see the difference in the structure between the on-earth type and the space-grown crystals.

What allows you to do this is the absence -- primarily the absence of gravity. On earth, every time you try to grow a crystal or even separate out very high molecular weight molecules, protein molecules, you find the convection is a problem. There is always a little convection in the solution or in the melt, and this will cause the crystals to be irregular or will cause the separation of biological materials to be incomplete.

There is no convection, of course, in the absence of gravity. And because of that, we were able to do much better separation and we can grow much purer crystals. And the Indian antimonite was only one example. We had about

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seven or eight different space manufacturing processes that turned out to be unique. The Indian antimonite was interesting in that it was a nice sized crystal and you could tell right away that it was a pure crystal and it was not perishable. And so that was the best thing for a gift to the President.

Now in the future, it is not just crystals and biological materials, but it is also new alloys. You can make many alloys and this is where your brand new alloys come in. You can make alloys in space that you cannot make on the ground at all because when you mix many metals they simply separate out.

A good example is gasoline and water. You mix those and the gasoline goes to the top and the water goes to the bottom, even if you shake it up very hard. Shake it up very hard in space, it stays that way. Nothing goes to the top and the bottom, because there is no top and bottom.

So you can make new alloys, absolutely new alloys in space that you could not make on the ground.

So it is a combination of the separation out of biological materials, the growth of more pure crystals than you can grow on the ground, and the creation of new alloys that lead these material scientist to think that there is between $1- and $2 billion a year worth of sales in this kind of business.

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QUESTION: You indicated that we would not be heading toward -- likely be heading toward a permanent space station, but the question is raised, would the moon not serve as a permanent space station, and have you plans in that direction?

DR. FLETCHER: I could answer the second part of that first.

We have no plans to establish a permanent base on the moon. We have made such plans in the past, so that we know what it would take. But, let me just say two things about manufacturing:

You would not use the moon for the manufacturing of the kind that I was talking about. It would not be a substitute for a space station because of course there is gravity, even though it is one-sixth of earth's.

The main reason for establishing a base on the moon would be, first of all scientific. You can set up observatories and measurement systems there that you cannot replace in any other way either in space or on earth.

A second possible reason for going to moon is for colonization. And there are some people that have made studies of space colonization, and there is a little bit of an argument as to whether the first colony should be on the moon, or whether it should be out in space.

And the most recent proposal is that by a young

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physicist from Princeton by the name of Gerald O'Neal, who has picked a place about 200 miles away from the moon, but in the lunar orbit as the place most likely, most easy to set up a space colony. And his plan would be to collect energy from the sun, which is easy to do, and to use that energy for keeping life maintained and mining the moon. Going to the moon only when you needed minerals, which you do in order to manufacture and build things in the space colony.

And that turns out to be a feasible thing to do, amazingly enough. It would be a cost though, comparable at least to the Apollo program. He thinks it would be about the same, and I don't think anybody has really estimated the cost.

But these are all possibilities for space colonies. I don't think the object, though, would be for manufacturing for industrial use, but rather to make sure that life was able to maintain itself elsewhere besides the earth.

VOICE: You have been listening to a presentation of Town Hall on the Air.

The speaker has been the Honorable James C. Fletcher, Administrator, National Aeronautics and Space Administration, addressing us on a Look at the New NASA Program.

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May I repeat that address; Town Hall, T-o-w-n, Town Hall, 523 West Sixth STreet, Los Angeles, California, 90014.

Please join Town Hall on the Air again next week for another interesting presentation.

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P74-10345 Corrected

Progress Report on the NASA
Space Program for the Seventies

Luncheon Talk

by

Dr. James C. Fletcher

Administrator

National Aeronautics and Space Administration

Town Hall of California

Los Angeles

December 3, 1974

We are now almost halfway through the decade of the Seventies. It is a good time to give you a progress report on the NASA Space Program for the Seventies.

Some people still wonder what has happened to the space program after completion of the mighty Apollo moon landing effort, which kept us so busy in the Sixties.

In answer to that question, I can say we are making significant progress in every major area of space exploration and space use, and we have every reason to expect this steady progress to continue through the 1980s as well.

We are moving ahead during this decade in five main areas of space activity. I will describe each of them briefly.

First, let me tell you how things are going in the Space Shuttle program. It is our major effort to develop new space capabilities in this decade, like the Apollo program was our major effort in the 1960s. It is an effort we are very proud of.

THE SPACE SHUTTLE IS, OF COURSE, SOMETHING THAT HAS NEVER BEEN BUILT BEFORE. FIRST WE HAD TO "INVENT" IT, AND MAKE SURE THAT WE COULD BUILD IT AT A REASONABLE COST. NOW WE ARE BUILDING IT. WE WILL BEGIN FLYING IT IN 1977. WE WILL BRING IT INTO OPERATIONAL USE IN 1980.

SOME OF YOU KNOW QUITE WELL WHAT THE SPACE SHUTTLE IS, AND WHY WE NEED IT. OTHERS MAY BE WONDERING. IN GENERAL TERMS, I THINK OF THE SPACE SHUTTLE AS THE KEY TO SUCCESSFUL USE OF SPACE, AND TO AMERICA'S FUTURE IN SPACE.

IN MORE SPECIFIC TERMS, THE SPACE SHUTTLE IS A REUSABLE SPACESHIP THAT WILL GIVE US A MUCH BETTER WAY, AND CHEAPER WAY, TO GET PAYLOADS OF ALL KINDS TO AND FROM EARTH ORBIT. IT WILL TAKE OFF LIKE A ROCKET, CRUISE IN EARTH ORBIT LIKE A SPACE STATION, AND RETURN TO EARTH FOR A RUNWAY LANDING JUST LIKE AN AIRLINER.

WE HAVE HAD STRONG SUPPORT FOR THE SHUTTLE IN THE WHITE HOUSE AND IN CONGRESS YEAR AFTER YEAR SINCE 1970. WE EXPECT TO BE ABLE TO COMPLETE THE SHUTTLE DEVELOPMENT EFFORT OVER THE NEXT FIVE YEARS WITHOUT EITHER TECHNOLOGICAL OR POLITICAL PROBLEMS.

WE MUST REMEMBER, HOWEVER, THAT THE SPACE SHUTTLE IS BASICALLY A TRUCK. ITS USEFULNESS DEPENDS ON WHAT IT HAULS, ON WHAT ITS PAYLOADS ARE. AND THAT BRINGS US TO THE SECOND MAIN AREA OF SPACE ACTIVITY I WANT TO REPORT ON.

IN THIS VERY IMPORTANT AREA -- WHICH WE CALL THE SPACE APPLICATIONS AREA -- WE ARE DEMONSTRATING THE PRACTICAL BENEFITS THAT CAN BE PRODUCED BY SPACECRAFT IN EARTH ORBIT.

EVEN AS WE BUILD THE SPACE SHUTTLE, WE MUST PLAN AND BUILD THE NEW APPLICATIONS SATELLITES -- THE NEW "WORKING" SATELLITES -- THAT THE SHUTTLE WILL PLACE IN EARTH ORBIT TO WIN MORE PRACTICAL BENEFITS.

YOU ARE ALREADY FAMILIAR WITH WEATHER AND COMMUNICATIONS SATELLITES. YOU MAY ALSO KNOW ABOUT THE RELATIVELY NEW EARTH RESOURCES TECHNOLOGY SATELLITE, OR ERTS-1, WHICH PRODUCES DETAILED IMAGES OF ALMOST EVERY PART OF THE GLOBE EVERY 18 DAYS. THESE IMAGES, WHEN ANALYZED BY COMPUTERS, YIELD VALUABLE INFORMATION ABOUT THE WORLD'S FOOD AND WATER SUPPLY, ABOUT LAND USES, AND ABOUT POSSIBLE NEW SOURCES OF SCARCE NATURAL RESOURCES.

OUR PRESENT APPLICATIONS SATELLITES WILL BE MADE LARGER, MORE VERSATILE, AND GENERALLY MUCH MORE PRODUCTIVE FOR USE IN THE SHUTTLE ERA. WE ARE ALSO FINDING NEW PRACTICAL USES FOR EARTH SATELLITES.

FOR EXAMPLE, WE HAVE ALREADY DEMONSTRATED HOW LABORATORIES IN EARTH ORBIT CAN TAKE ADVANTAGE OF THE COMPLETE VACUUM AND ZERO GRAVITY OF SPACE, AND USE THEM TO PRODUCE NEW OR BETTER PRODUCTS WHICH CANNOT BE PRODUCED ON EARTH. WE RAN SOME VERY SUCCESSFUL EXPERIMENTS IN SPACE MANUFACTURING DURING THE SKYLAB PROGRAM.

I RECENTLY HAD THE HONOR OF JOINING WITH A REPRESENTATIVE OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY (MR. HOWARD JOHNSON, CHAIRMAN OF THE BOARD) TO PRESENT TO PRESIDENT FORD A SMALL SEGMENT OF A UNIQUE AND VERY PROMISING KIND OF CRYSTAL WHICH WAS GROWN BY THE SKYLAB ASTRONAUTS IN THE ZERO GRAVITY OF SPACE. THE PRESIDENT CALLED THIS SYMBOLIC BIT OF SPACE-MADE CRYSTAL A REMINDER OF THE NEW OPPORTUNITIES AVAILABLE TO US THROUGH OUR NATIONAL INVESTMENT IN SCIENCE AND TECHNOLOGY.

CRYSTALS GROWN IN SPACE ARE EXPECTED TO BE OF GREAT VALUE IN DECREASING THE SIZE AND UPGRADING THE PERFORMANCE OF MANY KINDS OF ELECTRONIC DEVICES ESSENTIAL TO SCIENTIFIC AND INDUSTRIAL PROGRESS AND TO THE MAINTENANCE OF A HIGH STANDARD OF LIVING. VALUABLE NEW SERUMS TO FIGHT DISEASE ARE ALSO EXPECTED FROM SPACE LABORATORIES. SPACE MANUFACTURING IS A PROMISING NEW FIELD NOW OPENING UP TO AMERICAN INDUSTRY.

WE ARE ALSO INVESTIGATING OTHER PROMISING POSSIBILITIES FOR USING SPACECRAFT IN EARTH ORBIT. FOR EXAMPLE, WE ARE CHECKING OUT THE FEASIBILITY OF PUTTING VERY LARGE SATELLITES INTO ORBIT WHICH WOULD CONVERT THE SUN'S RAYS INTO ELECTRICITY AND BEAM IT TO EARTH STATIONS IN THE FORM OF MICROWAVES. THESE SATELLITE POWER STATIONS IN THE SKY, IF THEY PROVE FEASIBLE IN TERMS OF COST, COULD BE A MOST WELCOME ANSWER TO SOME OF OUR ENERGY AND POLLUTION PROBLEMS.

NOW LET ME TELL YOU ABOUT A THIRD MAIN AREA OF NASA SPACE ACTIVITY DURING THIS DECADE. IN ADDITION TO BUILDING MORE PRODUCTIVE APPLICATIONS SATELLITES, WE ARE ALSO WORKING ON NEW SCIENTIFIC SATELLITES TO USE IN EARTH ORBIT TO STUDY THE SOLAR SYSTEM AND THE UNIVERSE.

THE LARGE SPACE TELESCOPE WE ARE WORKING ON IS A GOOD EXAMPLE OF THE BIGGER AND BETTER SCIENTIFIC SATELLITES THE SPACE SHUTTLE WILL BE ABLE TO LAUNCH AND SERVICE IN THE 1980S AND 1990S.

THE LARGE SPACE TELESCOPE, AS ORIGINALLY PLANNED, WOULD WEIGH ABOUT 10 TONS, AND HAVE AN OPTICAL SYSTEM WITH A DIAMETER OF ABOUT 10 FEET. SOME EARTH-BASED TELESCOPES ARE LARGER. BUT BECAUSE THE LARGE SPACE TELESCOPE WILL OPERATE ABOVE THE BLANKET OF THE EARTH'S ATMOSPHERE, IT WILL BE MUCH MORE PRODUCTIVE THAN ANY EARTH-BASED TELESCOPE.

THE RESOLUTION OF THE LST IS IMPRESSIVE. IF YOU HAD IT MOUNTED IN LOS ANGELES, AND IF THE EARTH WAS FLAT, YOU COULD SEE THE HEADLIGHTS OF A CAR IN TOKYO, AND YOU COULD TELL THAT THE CAR HAD TWO HEADLIGHTS AND NOT JUST ONE.

THE LST WILL ENABLE ASTRONOMERS TO SEE 10 TIMES FURTHER INTO SPACE THAN THEY CAN NOW. IT MAY ENABLE THEM TO SEE TO THE EDGE OF THE UNIVERSE. WHEN WE USE THE LST TO LOOK AT DISTANT GALAXIES, WE WILL NOT SEE THEM AS THEY ARE TODAY, BUT AS THEY WERE BILLIONS OF YEARS AGO.

CLOSER TO HOME, THE LST MAY LET US SEE EVIDENCE OF PLANETS CIRCLING NEARBY STARS, PLANETS THAT OUR DESCENDANTS HUNDREDS OF YEARS FROM NOW MAY TRY TO VISIT, PLANETS THAT WE MAY CONTACT BY RADIO IN OUR OWN LIFETIMES.

EVEN SUPERIOR INSTRUMENTS LIKE THE LARGE SPACE TELESCOPE IN EARTH ORBIT CANNOT BEGIN TO TELL US ALL WE NEED TO KNOW ABOUT THE OTHER PLANETS OF THE SOLAR SYSTEM. THAT IS WHY WE HAVE A FOURTH MAIN AREA OF SPACE ACTIVITY -- PLANETARY EXPLORATION WITH THE USE OF SMALL AUTOMATED SPACECRAFT WHICH ARE PRODUCING AMAZING RESULTS.

IN OUR PLANETARY PROGRAMS FOR THIS DECADE AND THE NEXT, WE ARE PROCEEDING IN A METHODICAL, STEP-BY-STEP FASHION; BUT IN MANY WAYS THESE NEW VOYAGES OF DISCOVERY HAVE ALREADY BEEN AS EXCITING AND AS REWARDING AS OUR EXPLORATION OF THE MOON IN THE APOLLO PROGRAM. AND, OF COURSE, THEY HAVE BEEN MUCH LESS COSTLY.

WITHIN THE PAST YEAR, OUR SMALL AUTOMATED SPACECRAFT HAVE CARRIED OUT VERY SUCCESSFUL MISSIONS TO THREE DIFFERENT PLANETS -- VENUS, MERCURY, AND JUPITER. AND IN 1976 WE WILL LAND TWO VIKING SPACECRAFT ON MARS TO SEEK THE FIRST CONCRETE EVIDENCE OF EXTRATERRESTRIAL LIFE.

WE ARE VERY PROUD OF THE EXCELLENT PERFORMANCE OF THE TWO TINY SPACECRAFT, PIONEER 10 AND PIONEER 11, THAT WE HAVE SENT TO JUPITER AND BEYOND.

Pioneer 10 passed within about 81,000 miles of the liquid surface of Jupiter a year ago. Late last night Pioneer 11 passed much closer to Jupiter -- within 27,000 miles.

Pioneers 10 and 11 are the first spacecraft to explore the Outer Planets.

Their speed at launch had to be more than 32,000 miles per hour. That is why we were already 15 years into the Space Age before the first voyages to the Outer Planets were attempted.

Significant advances also had to be made in spacecraft technology and in inter-planetary communications before spacecraft like Pioneers 10 and 11 could be launched. That is why the United States is the only country which has attempted such missions to date.

These spacecraft are small -- they weigh less than 600 pounds each. But their performance and their reliability has been close to unbelievable.

For example, Pioneer 10 passed Jupiter exactly on target, with all instruments working, after a voyage of 641 days and more than half a billion miles.

WE ARE STILL IN TOUCH WITH PIONEER 10. IT SENDS US INFORMATION ABOUT THE AREA IT IS FLYING THROUGH WHENEVER WE ASK IT TO.

SENDING RADIO COMMANDS TO THE TWO PIONEER SPACECRAFT AND GETTING BACK COLOR IMAGES OF JUPITER AND DATA FROM THE OTHER MAJOR SCIENTIFIC INSTRUMENTS ABOARD HAS BEEN A TREMENDOUS COMMUNICATIONS ACHIEVEMENT.

KEEP IN MIND THAT PIONEER'S ANTENNA MUST ALWAYS BE POINTED TOWARD EARTH FOR SUCCESSFUL COMMUNICATIONS.

KEEP IN MIND THAT PIONEER'S RADIO TRANSMITTER DRAWS ONLY EIGHT WATTS OF POWER TO BEGIN WITH, AND THAT THESE SIGNALS ARE WEAKENED TO ONLY A TINY FRACTION OF A WATT BY THE TIME THEY REACH EARTH. (FOR THE ENGINEERS IN THE AUDIENCE, THIS TINY FRACTION OF A WATT IS 10^{-12} OR LESS. THAT'S ONE QUADRILLIONTH OR LESS.)

KEEP IN MIND THAT THESE INFINITESIMAL SIGNALS MUST BE PICKED UP BY ONE OF NASA'S THREE BIG-DISH ANTENNAS IN CALIFORNIA, SPAIN, OR AUSTRALIA, SEPARATED FROM ALL THE RADIO NOISE OF SPACE, AND AMPLIFIED TO READABLE STRENGTH.

Then consider that some of these signals, when enhanced through a special computer process at the University of Arizona, have produced excellent color images of Jupiter, and you will see why I consider Pioneers 10 and 11 one of the most remarkable creations of the Space Age.

We expect to maintain communications with Pioneer 10 until it passes the orbit of the planet Uranus sometime in 1979. Then it will be nearly two billion miles from Earth. But it will still take Pioneer 10 a long time to leave the Solar System after we bid it goodby. It will be 1987 before it crosses the orbit of the planet Pluto which is the outermost of the nine planets. We consider that the effective boundary of the Solar System. Thus, some 13 years from now, Pioneer 10 will become the first man-made object to cruise in interstellar space.

Pioneer 11 has also set a new speed record for man-made objects. By coming so close to Jupiter, and drawing on its gravity, it passed the giant planet at a speed of more than 100,000 miles per hour. That is 55 times faster than a bullet leaves the muzzle of an Army M-14 rifle.

SENDING PIONEER 11 THIS CLOSE TO JUPITER HAS BEEN A MOST REMARKABLE FEAT OF CELESTIAL NAVIGATION. WE LAUNCHED PIONEER 11 ON THE SAME CONSERVATIVE COURSE WE GAVE PIONEER 10, BECAUSE AT LAUNCH TIME PIONEER 10 HAD NOT YET REACHED JUPITER.

BUT WHEN THE RESULTS CAME IN FROM PIONEER 10, OUR SPACE NAVIGATORS AT AMES RESEARCH CENTER IN MOUNTAIN VIEW, CALIFORNIA, WERE ABLE TO ORDER PIONEER 11 TO CHANGE COURSE FOR A MUCH CLOSER LOOK AT JUPITER, FROM A NEW ANGLE.

WE ARE ALSO GETTING A BIG BONUS FROM THE PIONEER 11 COURSE CHANGE. WE ARE USING ITS INCREASED SPEED TO HURL IT BEYOND JUPITER ON A CAREFULLY CALCULATED TRAJECTORY WHICH WILL SEND IT CLOSE TO SATURN IN 1979. SATURN HAPPENS TO BE AT THE OPPOSITE END OF THE SOLAR SYSTEM AT PRESENT, SO PIONEER WILL TAKE FIVE YEARS TO GET THERE. WHEN IT FINALLY ARRIVES, IT WILL GIVE US OUR FIRST OPPORTUNITY TO SEE CLOSE UP WHAT THOSE RINGS ARE MADE OF.

PLANETARY EXPLORATION TAKES PATIENCE. IT CANNOT ALL BE DONE IN ONE BIG PUSH, LIKE THE APOLLO PROGRAM TO LAND ON THE MOON. WE HAVE TO MOVE STEP BY STEP, DECADE BY DECADE. BUT EVEN SO, A GREAT DEAL WILL BE LEARNED, AND MANY EXCITING VOYAGES WILL BE MADE, DURING THE REMAINDER OF THIS CENTURY, DURING OUR LIFETIMES.

Now let us look at some of our plans for ~~a fourth area of major activity~~ -- exploring the planets with larger and even more productive spacecraft in the years just ahead.

In 1977 we will launch two Mariner-type spacecraft to fly by both Jupiter and Saturn. These new spacecraft will weigh almost three times as much as Pioneers 10 and 11. They should give us much new information on the rings of Saturn and on one or more of the moons of Jupiter and Saturn.

According to tentative plans, we expect to launch as many as 10 Mariner or Pioneer spacecraft to the Outer Planets in the 1980s, including flybys of Uranus and Neptune, probes into the atmospheres of Jupiter, Uranus, and Saturn, and orbiters around Jupiter and Saturn. And in 1990 and 1991 we might send two very heavy spacecraft weighing 21,000 pounds each to orbit one of Jupiter's moons at an altitude of only 55 miles, and land an instrument package, including a TV camera, on this Jovian moon.

That takes us through 1991.

At the same time we will continue in a methodical way to explore the nearby planets, Venus and Mars.

As mentioned earlier, in 1976, probably on the Fourth of July, we will soft land a Viking spacecraft on the surface of Mars. This lander will carry TV cameras and a very sophisticated automated laboratory to seek evidence of life on Mars.

A second Viking Lander equipped with the same instruments will be sent to a different area of Mars a few days or weeks after the first one.

If we do obtain evidence of life on Mars, it will of course have profound impact on the thinking of mankind. And it will certainly add new impetus to our drive to explore the Solar System.

Needless to say, the phenomenal success of Pioneers 10 and 11 also helps win wide support for new efforts to carry on these great voyages of exploration, which are becoming recognized as one of the outstanding achievements of this century, comparable to the voyages of exploration that marked the 14th and 15th centuries.

~~You might be interested in some of the sophisticated techniques we plan to use when we send two Mariner-type satellites to orbit Jupiter in the 1980s.~~

You might be interested in some of the sophisticated techniques we plan to use when we send two Mariner type satellites to orbit Jupiter in the 1980s.

We call these techniques satellite "pumping" and satellite "cranking". With these techniques, we can use the gravity of the four large moons of Jupiter to move our Mariner spacecraft into a variety of favorable orbits, so that we can look at Jupiter not only from one vantage point, but many. And these techniques will also give us a number of opportunities to study the Jovian moons close up.

The satellite pumping technique uses the gravity of a Jovian moon to change the shape of our spacecraft's orbit without changing its inclination, or direction. The cranking technique uses the gravity of a Jovian moon to change the inclination of the spacecraft's orbit, so that it moves from an equatorial orbit to a near polar orbit, or anywhere in between.

So what we intend to do, and they are working on this at the Jet Propulsion Laboratory here in California, is to use the moons of Jupiter as "gravity engines" to steer our spacecraft to various vantage points. And with luck we may be able to view Jupiter from a wide variety of orbits and make 40 or 50 encounters with four of Jupiter's large satellites, all with one spacecraft, during a 30-month period.

IF WE DID NOT USE THESE PUMPING AND CRANKING TECHNIQUES, IT WOULD TAKE LARGE AMOUNTS OF ROCKET FUEL ABOARD THE SPACECRAFT TO ACHIEVE THE SAME RESULT. AND WITH ALL THIS ROCKET FUEL ABOARD, THE SPACECRAFT WOULD BE TOO HEAVY TO LAUNCH TO JUPITER IN THE FIRST PLACE.

WE WILL USE A MODEST AMOUNT OF ROCKET FUEL ABOARD THE SPACECRAFT TO ACHIEVE A LARGE LOOPING ORBIT AROUND JUPITER. BUT FOR CHANGES AND REFINEMENTS IN THAT ORBIT WE WILL USE THE JOVIAN MOONS AS OUR ENGINES.

I HAVE DESCRIBED THESE NEW TECHNIQUES IN SOME DETAIL BECAUSE I WANTED TO SHOW YOU HOW WE ARE LEARNING THE FINE ART OF "SAILING" OUR SPACECRAFT TO THE PLACES WE WANT THEM TO GO, EVEN AT DISTANCES OF HALF A BILLION MILES FROM EARTH. THAT IS WHY WE SAY THAT OUR SO-CALLED "UNMANNED" SPACECRAFT ARE INDEED MANNED AND CONTROLLED THROUGHOUT THEIR JOURNEY BY OUR SPACE NAVIGATORS LOCATED AT OUR CONTROL CENTERS IN CALIFORNIA.

NOW FOR THE FIFTH MAJOR AREA OF SPACE ACTIVITY IN THIS DECADE. IN ADDITION TO EXPLORING SPACE AND USING SPACECRAFT FOR PRACTICAL BENEFITS, WE ARE MAKING AN INTENSIVE AND CONTINUING EFFORT TO IDENTIFY WAYS IN WHICH NEW SPACE TECHNOLOGY AND SPACE SKILLS CAN BE PUT TO NON-SPACE USES HERE ON EARTH.

SPACE AGE TECHNOLOGY IS ALREADY BEING WIDELY EMPLOYED IN SUCH FIELDS AS MEDICINE, HOME AND INDUSTRIAL SAFETY, LAW ENFORCEMENT, ENVIRONMENTAL PROTECTION, THE DEVELOPMENT OF NEW ENERGY SOURCES, AND THE SOLUTION OF URBAN PROBLEMS. OUR STANDARD OF LIVING AND OUR WORLD TRADE POSITION DEPEND IN LARGE MEASURE ON OUR CONTINUING LEADERSHIP IN THE DEVELOPMENT AND USE OF NEW HIGH TECHNOLOGY. HIGH TECHNOLOGY IS TECHNOLOGY THE OTHER FELLOW DOESN'T HAVE YET. IT IS THE KIND OF TECHNOLOGY WE DEVELOPED IN THE SUPER-COMPUTERS AND THE SUPER-ENGINES THAT HELPED GET THE APOLLO ASTRONAUTS TO THE MOON AND BACK.

YOU MAY BE INTERESTED TO KNOW THAT ROCKET TECHNOLOGY DEVELOPED BY THE ROCKETDYNE DIVISION OF NORTH AMERICAN ROCKWELL AT CANOGA PARK, CALIFORNIA, FOR THE APOLLO PROGRAM, ~~IS NOW BEING USED~~ will be put to use in 1975 TO PRODUCE ELECTRICITY during peak demand periods IN A STEAM-GENERATING PLANT IN CHICAGO, ILLINOIS. THIS DOWN-TO-EARTH USE OF ROCKET TECHNOLOGY IS NOT A NASA PROJECT. IT HAS BEEN JOINTLY FUNDED BY ROCKETDYNE AND THE COMMONWEALTH EDISON COMPANY.

NASA does help American industry find new ways to use space-age technology. As part of what we call our Technology Utilization Program, NASA helps finance six Regional Dissemination Centers which function as data banks for new technology. Bring your down-to-Earth engineering problem to any of these Centers, and NASA know-how may help you solve it.

One of these six centers serves the West Coast. It is the Western Research Applications Center at the University of Southern California. This Center, like the other five, has computer access to the entire NASA data bank.

To continue now with my progress report on the space program for the Seventies, I would like to mention the success we are having in promoting international cooperation in space. Two examples are especially worth mentioning.

The first is the Apollo/Soyuz Test Project, which is our most important project, to date, for cooperation with the Soviet Union. This project calls for our Apollo spacecraft to link up with their Soyuz spacecraft in Earth orbit in July of next year. Preparations for this joint flight are proceeding smoothly. Our astronauts are learning Russian; the cosmonauts are learning English. The working relationships between the technical people on both sides have been very good.

Another important step forward in space cooperation is the recent decision of nine European countries to undertake the design and development of the Spacelab, which will be carried to Earth orbit and back aboard the Space Shuttle.

The Spacelab will be a prefabricated unit, something like a small house trailer, with standard laboratory equipment built in. There will also be ample room aboard the Spacelab for scientists to install the special equipment needed for each mission. There will also be room for up to four scientists and technicians to accompany their experiments into space. They will work in the Spacelab, and eat and sleep in the crew quarters of the Space Shuttle.

WHEN THE SHUTTLE OPERATES WITHOUT THE SPACELAB IT WILL SERVE AS AN EFFICIENT, REUSABLE SPACE TRUCK TO HAUL AUTOMATED SPACECRAFT TO EARTH ORBIT, TO SERVICE THEM THERE, AND, ON OCCASION, TO BRING THEM BACK TO EARTH FOR REPAIRS OR REFURBISHMENT.

BUT WHEN THE SPACELAB IS PUT ABOARD, THE SPACE SHUTTLE BECOMES MUCH MORE THAN A TRUCK. IT BECOMES A SMALL BUT VERY VERSATILE MANNED SPACE STATION FOR MISSIONS OF FROM SEVEN TO 30 DAYS.

THIS, THEN, BECOMES A REUSABLE MANNED SPACE STATION. THAT WORD REUSABLE IS ONE OF THE IMPORTANT MEASURES OF THE PROGRESS WE ARE MAKING IN THIS DECADE, COMPARED WITH THE 1960S.

THE REGULAR THREE-MAN CREW OF THE SPACE SHUTTLE WILL BE HIGHLY TRAINED ASTRONAUTS. BUT THE MEN AND WOMEN WHO WORK AS TECHNICIANS AND SCIENTISTS IN THE SPACELAB WILL NEED ONLY GENERAL GOOD HEALTH AND A BRIEF TRAINING PERIOD TO QUALIFY FOR SPACE FLIGHT. OF COURSE, THEY WILL ALSO HAVE TO HAVE A SPECIAL DESIRE TO WORK IN SPACE, AND WORTHWHILE EXPERIMENTS TO PERFORM.

To complete this brief progress report, let me say that we have space programs planned for this decade and the next that are challenging and that promise rich returns. We have space programs planned for this decade and the next that we Americans can be proud of, and that should help us to maintain our scientific and technological leadership in the world. And we have a space program that we can easily afford. We believe we can operate effectively in the decade ahead on annual budgets of around $3 billion.

With stabilized annual budgets around that level plus necessary adjustments for inflation, we believe we can continue to make steady progress in developing the practical and scientific uses of spacecraft in Earth orbit, in exploring with automated spacecraft throughout the Solar System, and in building and operating an efficient space transportation system based on the Space Shuttle.

At this halfway point in the decade, I think I can safely say that our well-balanced, low-cost space programs for the Seventies, focused mainly on practical benefits, have been well planned and are being executed in a highly competent manner by the NASA government-industry-university team.

I firmly believe we have earned continued strong support by the American people.

BEFORE WE GO TO THE QUESTION PERIOD, I WANT TO TALK A BIT MORE ABOUT OUR SPACE PROGRAM BUDGET IN THE YEARS JUST AHEAD.

WE HOPE WE CAN MAINTAIN THE PRESENT LEVEL OF SPACE EFFORT INTO THE NEXT DECADE, AND OUR LONG-RANGE PLANNING IS BASED ON THAT EXPECTATION.

WE REALIZE, OF COURSE, THAT IN THIS PERIOD OF EMPHASIS ON REDUCING THE FEDERAL BUDGET, SOME PEOPLE ARE GOING TO LOOK AT THE SPACE PROGRAM AS A LIKELY PLACE FOR SIGNIFICANT CUTS.

WE ARE PREPARED TO MAKE A CONVINCING CASE THAT THIS SHOULD NOT BE DONE, AND I WANT TO ENLIST YOUR HELP.

HOW VULNERABLE ARE WE?

WELL, PART OF OUR PROGRAM IS RELATIVELY IMMUNE TO BUDGET CUTTING:

-- WE HAVE TO CONTINUE A STRONG EFFORT IN AERONAUTICAL RESEARCH AND DEVELOPMENT, OR LOSE IMPORTANT FOREIGN MARKETS FOR AMERICAN AIRCRAFT. I BELIEVE THAT IS GENERALLY ACCEPTED AND UNDERSTOOD. THERE IS ALSO STRONG SUPPORT IN CONGRESS FOR OUR EFFORTS TO REDUCE AIRCRAFT NOISE AND POLLUTION, AND CONGESTION AROUND AIRPORTS. AND OUR EFFORTS TO MAKE AIRCRAFT MORE EFFICIENT IN TERMS OF FUEL CONSUMPTION CERTAINLY MAKE SENSE FOR THE YEARS AHEAD.

SO OUR AERONAUTICS BUDGET SHOULD NOT BE IN DANGER.

-- WE ALSO EXPECT THE NECESSARY FUNDING TO COMPLETE THE SPACE SHUTTLE ON SCHEDULE AND BRING IT INTO OPERATION IN 1980. WE HAVE REACHED A POINT IN THE SHUTTLE PROGRAM WHERE IT WOULD BE WASTEFUL TO TRY TO STRETCH IT OUT OR DELAY IT. THE SHUTTLE IS THE KEY TO CONTINUED AMERICAN PROGRESS IN USING EARTH ORBIT FOR PRACTICAL BENEFITS, AND I DON'T THINK CONGRESS IS ABOUT TO THROW THAT KEY AWAY.

-- DELAYING THE SHUTTLE NOW WOULD ALSO UPSET THE EUROPEAN SCHEDULE FOR DEVELOPING THE SPACELAB. HAVING CONVINCED THE EUROPEANS OF THE WISDOM OF INVESTING MORE THAN $400 MILLION OF THEIR OWN MONEY IN SPACELAB, WE CERTAINLY WOULD NOT WANT TO DISCOURAGE THEM IN ANY WAY. SPACELAB IS OUR MOST IMPORTANT INTERNATIONAL EFFORT TO DATE, AND SHOULD LEAD TO GREATLY INCREASED COOPERATION AND COST SHARING.

-- WE EXPECT CONTINUED STRONG SUPPORT FOR OUR APPLICATIONS PROGRAMS -- THAT IS, FOR OUR PROGRAMS TO WIN PRACTICAL BENEFITS FROM SPACECRAFT IN EARTH ORBIT. CONGRESS HAS BEEN VERY INTERESTED IN THE POTENTIAL FOR EARTH OBSERVATION SATELLITES AND IMPROVED WEATHER SATELLITES. THE COMMUNICATIONS INDUSTRY WANTS US TO SPEND MORE, NOT LESS, ON DEVELOPING NEW SPACE COMMUNICATIONS TECHNOLOGY. AND SO ON.

IT IS EASY TO SHOW THAT APPLICATIONS SATELLITES ARE A GOOD INVESTMENT.

SO, IF WE BECOME VULNERABLE TO BUDGET CUTTING IN ANY MAJOR AREA OF NASA ACTIVITIES IN THE YEARS AHEAD, IT MAY BE IN OUR SPACE SCIENCE PROGRAMS TO STUDY THE UNIVERSE FROM EARTH ORBIT AND IN OUR PLANETARY PROGRAMS TO SEND AUTOMATED SPACECRAFT TO EXPLORE THROUGHOUT THE SOLAR SYSTEM.

WE DO HAVE STRONG SUPPORT FROM THE SCIENTIFIC COMMUNITY AND MANY MEMBERS OF CONGRESS FOR THESE SCIENTIFIC PROGRAMS. BUT IT IS EASY FOR SHORTSIGHTED CRITICS TO SAY, "WELL, THESE SCIENTIFIC PROGRAMS ARE SOMETHING YOU DON'T HAVE TO DO NOW. THEY CAN WAIT." WE HAVE ALREADY RUN INTO THIS KIND OF OPPOSITION TO OUR PLANS TO PUT THE LARGE SPACE TELESCOPE IN ORBIT IN THE EARLY 1980S.

IN SUPPORT OF OUR SCIENTIFIC AND PLANETARY PROGRAMS, I WOULD LIKE TO MAKE FIVE MAIN POINTS:

POINT ONE. IT IS INCORRECT TO SAY THAT SPACE SCIENCE PROGRAMS CAN BE PUT OFF INDEFINITELY. WE NOW HAVE THE TEAMS IN BEING TO DO THIS KIND OF WORK; THEY ARE AN IMPORTANT NATIONAL RESOURCE, AN IMPORTANT RESOURCE OF MANKIND; THEY MUST BE GIVEN CHALLENGING WORK TO DO, OR THEIR UNIQUE SKILLS AND EXPERIENCE WILL BE LOST. SPACE EXPLORATION, TO BE PRODUCTIVE, CANNOT BE A NOW-AND-THEN ACTIVITY.

POINT TWO. SPACE SCIENCE DOES PRODUCE PRACTICAL BENEFITS. WE CANNOT ALWAYS PREDICT WHAT THEY WILL BE, BUT THEY ARE INEVITABLE. THE MORE WE LEARN ABOUT THE ATMOSPHERES OF OTHER PLANETS, THE BETTER WE WILL BE ABLE TO UNDERSTAND THE WEATHER AND CLIMATE OF EARTH, AND THE BETTER WE WILL BE ABLE TO PROTECT OUR ATMOSPHERE FROM THE KINDS OF POLLUTION THAT MAY DESTROY LIFE ON THIS PLANET IF WE ARE NOT CAREFUL.

IN THE PAST, SCIENTISTS WHO SPECIALIZE IN COMPARATIVE PLANETOLOGY HAVE BEEN VERY CAUTIOUS ABOUT CLAIMING THAT THE STUDY OF OTHER PLANETS WILL HELP ANSWER QUESTIONS OF PRACTICAL VALUE ABOUT PLANET EARTH.

HOWEVER, THAT RETICENCE IS BREAKING DOWN VERY RAPIDLY AS MORE AND MORE USEFUL APPLICATIONS OF PLANETARY STUDIES HAVE BEEN DEMONSTRATED.

FOR EXAMPLE, STUDY OF THE WEATHER ON MARS HAS SUBSTANTIALLY IMPROVED THE ACCURACY OF WEATHER PREDICTING ON EARTH.

HERE IS ANOTHER EXAMPLE OF THE PRACTICAL IMPORTANCE OF STUDYING OTHER PLANETS. IT IS A DRAMATIC ONE, AND NO DOUBT CONTROVERSIAL. BUT IT MAY PROVE TO BE A SIGNIFICANT CONTRIBUTION TO THE CONTINUING DEBATE ON WHETHER THE SMOG WHICH MODERN SOCIETY IS SENDING INTO THE ATMOSPHERE WILL HELP TO BRING ON ANOTHER ICE AGE.

I WOULD LIKE TO QUOTE DIRECTLY FROM A RECENT STATEMENT PREPARED IN THE PLANETARY PROGRAMS OFFICE AT NASA HEADQUARTERS. IT SAYS:

"IT HAS LONG BEEN ESTABLISHED THAT A SUSTAINED DROP IN THE AVERAGE TEMPERATURE OF THE EARTH'S ATMOSPHERE OF ONLY FOUR DEGREES CENTIGRADE COULD TRIGGER ANOTHER DISASTROUS ICE AGE.

HOWEVER, IT HAS BEEN VERY MUCH DEBATED WHETHER THE AEROSOLS (SMOKE, DUST, AND OTHER POLLUTANTS) THAT WE ARE DUMPING INTO THE EARTH'S ATMOSPHERE WOULD CAUSE A TEMPERATURE RISE OR TEMPERATURE DECREASE. ONE ARGUMENT SAID THAT THE SMOG WOULD BLOCK HEAT FROM THE SUN FROM REACHING THE EARTH'S SURFACE AND THEREFORE WOULD CAUSE A COOLING TREND. THE COUNTER ARGUMENT SAID THAT THE SMOG WOULD PREVENT INFRARED HEAT FROM RADIATING OFF INTO SPACE AND WOULD THEREFORE INCREASE THE TEMPERATURE.

"THE ANSWER TO THIS DEBATE CAME FROM MARINER 9 DATA DURING THE CLEARING OF THE GREAT 1971 DUST STORM ON MARS. TEMPERATURE PROFILES ALL THE WAY DOWN THROUGH THE ATMOSPHERE TO THE SURFACE WERE CONTINUALLY RECORDED AS THE MARS ATMOSPHERE WENT FROM A VERY DUST-FILLED CONDITION TO A FINAL CLEAR STATE. IT WAS SHOWN THAT THE FINE AEROSOL DUST PARTICLES CAUSED A DROP OF OVER 20°C IN THE SURFACE TEMPERATURE ON MARS, CONFIRMING THAT MUCH MORE SMOG AEROSOL POLLUTION IN EARTH'S ATMOSPHERE COULD, INDEED, SET OFF ANOTHER ICE AGE."

AS MIGHT BE EXPECTED, THIS FORTHRIGHT OPINION IS NOT YET FULLY ACCEPTED IN THE SCIENTIFIC COMMUNITY; BUT I THINK IT ILLUSTRATES VIVIDLY THE KIND OF CONTRIBUTIONS OUR PLANETARY INVESTIGATIONS CAN MAKE TO IDENTIFYING AND SOLVING VITAL PROBLEMS AFFECTING THE FUTURE OF LIFE ON EARTH.

IT IS ALSO REWARDING TO LOOK BEYOND THE SOLAR SYSTEM FOR NEW KNOWLEDGE OF GREAT POTENTIAL PRACTICAL VALUE.

IN THE EARLY DECADES OF THIS CENTURY, ASTRONOMERS WHO STUDIED THE SUN PAVED THE WAY FOR THE ATOMIC AGE. OUR SPACE SCIENCE PROGRAMS TODAY WILL HELP US HARNESS THE POWER OF NUCLEAR ~~FISSION~~ FUSION [redacted] FOR PEACEFUL PURPOSES; AND OUR STUDY OF QUASARS, PULSARS, AND BLACK HOLES FAR OUT IN THE UNIVERSE MAY LEAD US TO NEW SOURCES OF ENERGY MORE POWERFUL THAN ANY WE COMPREHEND TODAY.

NOW FOR MY THIRD POINT ON WHY NASA SPACE SCIENCE AND PLANETARY PROGRAMS DESERVE CONTINUED STRONG SUPPORT.

These programs force the development of valuable new technology. Our development of atomic power sources for the tiny Pioneer spacecraft that are exploring Jupiter and Saturn is one example out of many. The automated laboratories we will land on Mars in 1976 will advance the art and science of cybernetics and benefit us in many ways.

As a nation, we make an important part of our living from the sale of high technology products and processes abroad.

I don't know a better way for the Federal Government to help American industry keep ahead of the competition in high technology than by steadily increasing our capabilities to explore throughout the Solar System and to seek basic understanding of how the Universe works.

Now, Point Four. I consider the exploration of space, and study of the Universe from Earth orbit, the kind of national undertaking that inspires us and encourages us as a people, that makes us proud to be Americans, that makes us want to excel at whatever we are doing, whether it is farming, or manufacturing, or teaching, or craftsmanship, or management.

Success in such programs as Pioneer 10 and 11 is one of the good things happening in our country today. We should keep them happening. We need the intellectual exercise. We need the warm glow of success.

POINT FIVE. FINALLY, I WANT TO TALK ABOUT OUR SPACE SCIENCE PROGRAMS AND OUR VOYAGES TO THE PLANETS AS A SPECIAL KIND OF INVESTMENT. THEY ARE MORE THAN AN INVESTMENT IN HIGH TECHNOLOGY, OR IN POTENTIAL PRACTICAL BENEFITS. THEY ARE MORE THAN AN INVESTMENT IN A BETTER AMERICA. I SPEAK NOW OF A LONG-TERM INVESTMENT IN THE FUTURE OF THE HUMAN RACE. WE HAVE THE CAPABILITY TO BEGIN ACQUIRING THE TECHNOLOGY AND THE EXPERIENCE WE NEED TO MOVE SOME OF OUR PEOPLE BEYOND PLANET EARTH AND ESTABLISH THE FIRST COLONIES IN EARTH ORBIT, OR SOLAR ORBIT, OR ON THE PLANETS. NO OTHER HUMAN BEINGS IN THE HISTORY OF THE WORLD HAVE HAD SUCH CAPABILITIES. OUR FOREFATHERS DOWN THROUGH THE AGES COULD ONLY DREAM OF SUCH VENTURES. WE HAVE THE CAPABILITIES AND THE CLEAR CHALLENGE TO START MAKING THESE DREAMS COME TRUE. THE PRESENT STATE OF THE WORLD, WITH THREATENED OVERCROWDING AND DIMINISHING NATURAL RESOURCES, IS GIVING US A PUSH, TOO. PIONEER, AND MARINER, AND VIKING ARE BLAZING THE TRAIL FOR US. LET'S KEEP THEM ON THE JOB. LET'S PREPARE, IN DUE TIME, TO FOLLOW THEM. IN YOUR LIFETIME, AND MINE.

I THANK YOU.